[Title of the Document] Abstract

A multilayer film of which the optical properties hardly change due to heat and where detachment hardly occurs between layers is provided. In addition, a multilayer film which is appropriate for decorative materials used as construction materials, wrapping, the interior and exterior of automobiles and the like, anti-counterfeit materials, for example holograms, various types of displays, such as liquid crystal displays, plasma displays, field emission displays and organic electronic displays, reflective materials and optical filters for optical devices, such as optical printing devices, cameras and the like, heat ray blocking window films for automobiles and construction materials, and reflectors for solar batteries is provided.

A multilayer film is provided with a structure where five or more layers made of thermoplastic resin A (layers A) and five or more layers made of thermoplastic resin B (layers B) having a basic skeleton that is the same as that of thermoplastic resin A are alternately layered on top of each other, and is characterized in that at least one reflection peak is provided and the difference between the reflectance of the reflection peak before heating and after heating for 30 minutes in an atmosphere of 150°C is no greater than 15%.

[Title of the Document] Drawings

[Fig 1]

[Fig 2]

[Fig 3]

[Fig 4]

[Fig 5]

[Table 1]

		Example 1	Example 2	Example 3	Example 4
Layer structure	Thermoplastic resin A	PET	PET	PET	PET
	Thermoplastic resin B	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET
	Number of layers	203	53	803	203
	Thickness ratio of layer A to adjacent layer B	0.95	0.95	0.95	1.89
Optical properties before heating	Reflectance at peak of reflection R1 (%)	93	57	92	94
	Wavelength at peak of reflection (nm)	678	678	900-1050	1530
	Reflectance in secondary reflection band (%)	11	11	11	82
	Wavelength in secondary reflection band (nm)	339	339	450-525	765
	Reflectance in tertiary reflection band (%)	Undetectable	Undetectable	73	11
	Wavelength in tertiary reflection band (nm)	Undetectable	Undetectable	300-350	510
	Reflectance in quaternary reflection band (%)	Undetectable	Undetectable	Undetectable	83
	Wavelength in quaternary reflection band (nm)	Undetectable	Undetectable	Undetectable	383
	Difference in reflectance in direction of width (%)	10	8	7	8
Optical properties after heating	Reflectance at peak of reflection R2 (%)	90	56	92	91
	R1-R2 (%)	3	1	0	3
Detachment test	Number of detached lattices	0	0	0	0
	Amount of heat at peak of heat emission (J/g)	0	0	0	0
	Squared value of correlation coefficient in linear approximation	0.22	0.31	0.55	0.19
	Squared value of correlation coefficient Inquadratic polynomial approximation	0.25	0.35	0.58	0.21
	Unevenness in layers (%)	6	5	18	5
Ratio of thermal contraction	Longitudinal direction (%)	0.2	0.5	0.2	0.2
	Direction of width (%)	0.2	0.3	0.2	0.2

[Table 2]

Layer structure		Example 5	Example 6	Example 7	Example 8
	Thermoplastic resin A	PET	PET	PET	PET
	Thermoplastic resin B	CHDM copolymerized PET + PET	Adipic acid · CHDM copolymerized PET	CHDM copolymerized PET	CHDM copolymerized PET
	Number of layers	203	203	203	203
	Thickness ratio of layer A to adjacent layer B	3.2	0.95	1.89	1.89
Optical properties before heating	Reflectance at peak of reflection R1 (%)	94	98	91	95
	Wavelength at peak of reflection (nm)	1531	677	1530	1530
	Reflectance in secondary reflection band (%)	82	10	81	82
	Wavelength in secondary reflection band (nm)	766	338	765	765
	Reflectance in tertiary reflection band (%)	78	88	12	11
	Wavelength in tertiary reflection band (nm)	510	223	510	510
	Reflectance in quaternary reflection band (%)	66	Undetectable	81	70
	Wavelength in quaternary reflection band (nm)	383	Undetectable	383	383
	Difference in reflectance in direction of width (%)	10	5	23	2
Optical properties after heating	Reflectance at peak of reflection R2 (%)	91	95	85	90
	R1-R2 (%)	3	3	6	5
Detachment test	Number of detached lattices	0	2	0	0
Amount of heat at peak of heat emission	(J/g)	0	5	0	0
	Squared value of correlation coefficient in linear approximation	0.17	0.22	0.19	0.19
	Squared value of correlation coefficient inquadratic polynomial approximation	0.19	0.25	0.21	0.21
	Unevenness in layers (%)	4	6	14	5
Ratio of thermal contraction	Longitudinal direction (%)	0.2	0.2	1.4	0.2
	Direction of width (%)	0.2	0.2	0.3	0.2

[Table 3]

		Comparative Example 1		Comparative Example 2		Comparative Example 3		Comparative Example 9	
Layer structure	Thermoplastic resin A	PET		PET		PET		PET	
	Thermoplastic resin B	Isophthalic acid copolymerized PET		Isophthalic acid copolymerized PET		CHDM copolymerized PET + PET		CHDM copolymerized PET + PET	
	Number of layers	203		203		131		203	
	Thickness ratio of layer A to adjacent layer B	0.95		0.95		0.95		0.95	
	Reflectance at peak of reflection R1 (%)	71		80		(25)		95	
	Wavelength at peak of reflection (nm)	678		680		560		535	
Optical properties before heating	Reflectance in secondary reflection band (%)	11		11		20		Undetectable	
	Wavelength in secondary reflection band (nm)	339		340		280		Undetectable	
	Reflectance in tertiary reflection band (%)	Undetectable		Undetectable		Undetectable		Undetectable	
	Wavelength in tertiary reflection band (nm)	Undetectable		Undetectable		Undetectable		Undetectable	
	Reflectance in quaternary reflection band (%)	Undetectable		Undetectable		Undetectable		Undetectable	
	Wavelength in quaternary reflection band (nm)	Undetectable		Undetectable		Undetectable		Undetectable	
	Difference in reflectance in direction of width (%)	8		7		10		10	
Optical properties after heating	Reflectance at peak of reflection R2 (%)	43		55		(27)		89	
	R1-R2 (%)	28		25		-		6	
Detachment test	Number of detached lattices	4		6		0		0	
Amount of heat at peak of heat emission	(J/g)	5.1		12		0		0	
	Squared value of correlation coefficient in linear approximation	0.21		0.21		0.09		0.22	
	Squared value of correlation coefficient in quadratic polynomial approximation	0.24		0.24		0.1		0.24	
	Unevenness in layers (%)	6		6		60		4	
Ratio of thermal contraction	Longitudinal direction (%)	0.2		0.2		0.2		0.2	
	Direction of width (%)	0.2		0.2		0.2		0.2	
Film thickness	Average thickness (µm)	21.1		21.1		-		15.5	
	Ratio of variation in thickness (%)	1.6		1.4		-		15	
	Wave number (1/m)	1.2		1.2		-		20	
	Pw	0.03		0.02		-		0.75	

[Table 4]

Item	Unit	Example 10	Example 11	Example 12	Comparative Example 4
Layers A	–	PET	PET	PET	PET
Layers B	–	PE/CHDM-T	PE/CHDM-T	PE/CHDM-T	PET/A
Number of layers	–	803	803	803	803
Film thickness	μm	128	130	128	128
Thickness ratio Z of layer A to adjacent layer B	–	1	0.95	3.5	1
Low wavelength end $\lambda 1$	nm	820	840	800	820
Low wavelength end $\lambda 2$	nm	1100	1125	1060	1100
XA1	nm	128	128	194	128
XA2	nm	172	171	258	172
XB1	nm	128	135	56	128
XB2	nm	172	180	74	172
Number of layers A having thickness of XA1 to XA2	Layers	396	398	401	396
Number of layers B having thickness of XB1 to XB2	Layers	395	397	397	395
Profile in layer thickness	–	Sloping type	Sloping type	Sloping type	Sloping type
Structure of surface layer(outermost layer)	(Structure)	Polyester based adhesive layer	Polyester based adhesive layer	Polyester based adhesive layer	Polyester based adhesive layer
Structure of surface layer(second layer)	(Structure)	PET layer	PET layer	PET layer	PET layer
	nm	50	50	50	50
	μm	5	5	5	5
Reflectance at peak of reflection (R1)	%	101	102	78	103
Range of reflectance within peak of reflection	%	8	8	8	5
Difference in reflectance in direction of width	%	3	2	3	2
Reflectance at peak of reflection after heating (R2)	%	96	95	72	80
R1-R2	%	5	7	6	23
Detachment test	Number of detached lattices	1	1	1	6
Squared value of correlation coefficient in linear approximation		0.71	0.71	0.77	0.7
Squared value of correlation coefficient in quadratic polynomial approximation		0.72	0.72	0.77	0.72
Unevenness in layers (%)	%	12	12	12	12
Reflectance in secondary reflective band (%)	%	14	11	70	15
Difference in reflectance in direction of width of secondary reflective band (%)	%	5	2	5	5
DSC (amount of heat at peak of heat emission)	J/g	0	0	0	18
Number of scratches	Number	3	3	5	3
Expansion system	–	Simultaneous biaxial expansion	Simultaneous biaxial expansion	Simultaneous biaxial expansion	Simultaneous biaxial expansion

[Table 5]

Item	Unit	Example 10	Example 14	Example 15	Example 16
Layers A	-	PET	PET	PET	PET
Layers B	-	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET
Number of layers	-	803	803	803	803
Film thickness	μm	128	128	118	138
Thickness ratio Z of layer A to adjacent layer B	-	0.95	0.95	0.95	0.95
Low wavelength end λ1	nm	820	820	800	850
Low wavelength end λ2	nm	1100	1100	1100	1140
XA1	nm	125	125	122	129
XA2	nm	167	167	167	174
XB1	nm	131	131	128	136
XB2	nm	176	176	176	183
Number of layers A having thickness of XA1 to XA2	Layers	395	396	360	379
Number of layers B having thickness of XB1 to XB2	Layers	396	395	357	378
Profile in layer thickness	-	Sloping type	Sloping type	Sloping type	Sloping type
Structure of surface layer(outermost layer)	(Structure)	PET + spherical silica layer	Polyester based adhesive layer	Polyester based adhesive layer	Polyester based adhesive layer
	nm	5000	50	50	50
Structure of surface layer(second layer)	(Structure)	-	PET layer	.	PET layer
	μm	-	5	.	5
Reflectance at peak of reflection (R1)	%	102	103	95	100
Range of reflectance within peak of reflection	%	5	5	15	12
Difference in reflectance in direction of width	%	3	5	5	3
Reflectance at peak of reflection after heating (R2)	%	97	99	92	96
R1-R2	%	5	4	3	4
Detachment test	Number of detached lattices	0	0	0	0
Squared value of correlation coefficient in linear approximation		0.71	0.71	0.6	0.39
Squared value of correlation coefficient in quadratic polynomial approximation		0.72	0.72	0.7	0.75
Unevenness in layers (%)	%	12	12	13	16
Reflectance in secondary reflective band (%)	%	11	12	12	11
Difference in reflectance in direction of width of secondary reflective band (%)	%	2	4	4	2
DSC (amount of heat at peak of heat emission)	J/g	0	0	0	0
Number of scratches	Number	3	14	30	5
Expansion system	-	Simultaneous biaxial expansion	Consecutive biaxial	Consecutive biaxial	Simultaneous biaxial expansion

[Table 6]

Item	Unit	Example 17	Example 18	Example 19	Example 20
Layers A	–	PET	PET + spherical silica	PET	PET
Layers B	–	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET
Number of layers	–	803	801	403	203
Film thickness	μm	128	128	71	41
Thickness ratio Z of layer A to adjacent layer B	–	0.95	0.95	0.95	0.95
Low wavelength end λ1	nm	850	820	850	850
Low wavelength end λ2	nm	1160	1100	1150	1150
XA1	nm	129	125	129	129
XA2	nm	177	167	175	175
XB1	nm	136	131	136	136
XB2	nm	186	176	184	184
Number of layers A having thickness of XA1 to XA2	Layers	399	375	190	96
Number of layers B having thickness of XB1 to XB2	Layers	399	370	187	95
Profile in layer thickness	–	Recess type	Sloping type	Sloping type	Sloping type
Structure of surface layer (outermost layer)	(Structure)	Polyester based adhesive layer	–	Polyester based adhesive layer	Polyester based adhesive layer
	nm	50	–	50	50
Structure of surface layer (second layer)	(Structure)	PET layer	–	PET layer	PET layer
	μm	5	–	5	5
Reflectance at peak of reflection (R1)	%	100	98	81	59
Range of reflectance within peak of reflection	%	11	11	21	25
Difference in reflectance in direction of width	%	3	2	2	8
Reflectance at peak of reflection after heating (R2)	%	97	93	79	50
R1-R2	%	3	5	2	9
Detachment test	Number of detached lattices	0	0	0	0
Squared value of correlation coefficient in linear approximation		0.39	0.6	0.7	0.3
Squared value of correlation coefficient in quadratic polynomial approximation		0.75	0.7	0.72	0.32
Unevenness in layers (%)		16	13	14	4
Reflectance in secondary reflective band (%)		11	12	11	11
Difference in reflectance in direction of width of secondary reflective band (%)		2	4	2	2
DSC (amount of heat at peak of heat emission)	J/g	0	0	0	0
Number of scratches	Number	4	3	5	4
Expansion system	–	Simultaneous biaxial expansion	Simultaneous biaxial expansion	Simultaneous biaxial expansion	Simultaneous biaxial expansion

[Table 7]

Item	Unit	Example 21	Example 22	Example 23	Comparative Example 6
Layers A	-	PET	PET	PET	PET
Layers B	-	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	CHDM copolymerized PET + PET	PET/I
Number of layers	-	403	803	1603	803
Film thickness	μm	85	150	225	128
Thickness ratio Z of layer A to adjacent layer B	-	1	1	2	1
Low wavelength end λ1	nm	800	600	390	820
Low wavelength end λ2	nm	1650	1650	1250	1100
XA1	nm	125	94	81	128
XA2	nm	258	258	260	172
XB1	nm	125	94	41	128
XB2	nm	258	258	130	172
Number of layers A having thickness of XA1 to XA2	Layers	199	360	401	396
Number of layers B having thickness of XB1 to XB2	Layers	198	350	400	395
Profile in layer thickness	-	Sloping type	Sloping type	Sloping type	Sloping type
Structure of surface layer(outermost layer)	(Structure)	PET + spherical silica layer	Polyester based adhesive layer	Polyester based adhesive layer	Polyester based adhesive layer
	nm	50	50	50	50
Structure of surface layer(second layer)	(Structure)	PET layer	PET layer	PET layer	PET layer
	μm	5	5	5	5
Reflectance at peak of reflection (R1)	%	55	71	104	83
Range of reflectance within peak of reflection	%	30	41	3	16
Difference in reflectance in direction of width	%	5	5	3	21
Reflectance at peak of reflection after heating (R2)	%	47	63	98	64
R1-R2	%	8	8	6	19
Detachment test	Number of detached lattices	0	0	0	4
Squared value of correlation coefficient in linear approximation		0.91	0.95	0.87	0.4
Squared value of correlation coefficient in quadratic polynomial approximation		0.92	0.95	0.87	0.41
Unevenness in layers (%)		25	28	30	21
Reflectance in secondary reflective band (%)		14	-	-	18
Difference in reflectance in direction of width of secondary reflective band (%)		5	-	-	11
DSC (amount of heat at peak of heat emission)	J/g	0	0	0	0
Number of scratches	Number	18	20	3	3
Expansion system	-	Consecutive biaxial	Consecutive biaxial	Simultaneous biaxial expansion	Simultaneous biaxial expansion